# ON THE ANATOMY OF NYCTIBIUS WITH NOTES ON ALLIED BIRDS.

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The sternum and foot of the genus *Nyctibius* have been described by P. L. Sclater,[1] and an account of the palate was given many years ago by Huxley,[2] but little has been published on the anatomy of the soft parts of these birds so far as is known. Through the courtesy of Dr. C. W. Richmond, acting curator in the Division of Birds, United States National Museum, the writer has been permitted to dissect the body, preserved in alcohol, of the type-specimen of the Potoo described recently as *Nyctibius griseus abbotti*.[3] This bird (Cat. No. 225851, U.S.N.M.), a male, was collected by Dr. W. L. Abbott at Port de Pimenti, northwest Hayti, on March 9, 1917. Though this specimen comprised the trunk and viscera alone, several points of interest were brought out by critical examination. An account of the dissections made is given in the following pages.

The esophagus was contracted, and in this state had strong thickened walls, with the inner surface thrown into a series of longitudinal folds or rugae that expanded anteriorly to join the broader surface of the pharynx. Apparently the esophagus was capable of great distension in life, and the bird must have been able to swallow any object that could pass the opening guarded by the furculum and the vertebrae at the anterior end of the body cavity. The proventriculus was large and glandular, and the stomach proper was comparatively thick walled and strong. This bird probably regurgitates pellets composed of chitinous fragments of insects and other indigestible matter, as the pyloric opening of the ventriculus was too small to allow particles of any size to pass. In the present instance the stomach contained insect jaws and other fragments too large to pass through into the small intestine and too firm in texture to permit of trituration.

[1] Notes upon the American Caprimulgidae, Proc. Zool. Soc. London, 1866, pp. 123–130.
[2] On the Classification of Birds, Proc. Zool. Soc. London, 1867, p. 454.
[3] Richmond, C. W., Descriptions of two new Birds from Haiti, Smiths. Misc. Coll., vol. 68, No. 7, July 12, 1917, p. 1.

The convolutions of the gut were of the isocoelous type. When removed from the body and dissected out, a large duodenal loop (see fig 1) was found, in which the intestine was larger in diameter than elsewhere. The remainder of the small intestine was thrown out in one large loop with three smaller divisions indicated. The remnant of the vitelline duct apparently was near the summit of the second of these smaller divisions, but it could not be made out exactly and the position assigned to it in the accompanying figure is somewhat uncertain. The caeca were paired and much elongated. At the open end each caecum was slender, while for its posterior half each was much dilated. The intestine was somewhat narrowed at the point where the caeca were given off, and then expanded into the rectum. Measurements of the intestine were taken as follows:

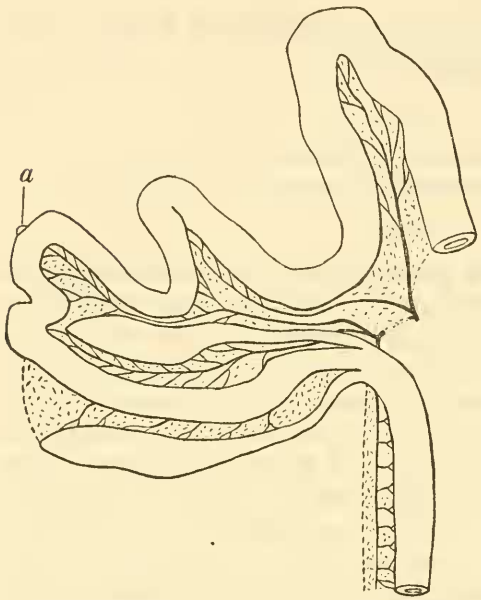


FIG. 1.—DIAGRAM OF THE INTESTINAL CONVOLUTIONS IN NYCTIBIUS GRISEUS ABBOTTI (ABOUT NATURAL SIZE). *a*, REMNANT OF VITELLINE DUCT.

| | *mm.* |
|---|---|
| Total length | 250 |
| Distance from caeca to anus | 30 |
| Length of caeca | 42 |

The liver (fig. 2) was bilobate, with the left division only about one-fifth the size of the right. The left lobe was elongate and flaplike, and measured 20 mm. long by 11 mm. wide. The right lobe was somewhat triangular in outline, with a broad, square-angled lower margin. The width of this lobe decreased toward its anterior end, where it was more or less squarely truncated. The external margin was straight and the internal border, forming one side of the cavity to receive the lower end of the pericardium, was sinuate. Through the center this lobe was 33 mm. long. The tips of the two lobes converged toward one another, though medially the right and left divisions were separated by a comparatively broad space. At

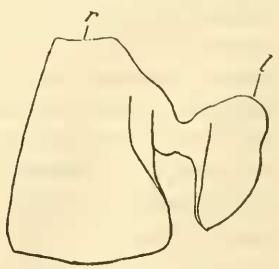


FIG. 2.—OUTLINE OF LIVER LOBES OF NYCTIBIUS GRISEUS ABBOTTI FROM THE VENTRAL SURFACE (SLIGHTLY LESS THAN NATURAL SIZE). *r*, RIGHT LOBE; *l*, LEFT LOBE.

the anterior end the two lobes were connected by a band of liver tissue 7 mm. long. This band was broad where it joined the left lobe, expanded by a rounded process on its lower margin, and then contracted to a narrow neck to join the right lobe. The small size of the left liver lobe is unusual, as in allied forms concerning which information or specimens are available (*Podargus*, *Caprimulgus*, *Phalaenoptilus*, *Setochalcis*, *Nyctidromus*, and *Chordeiles*) the left lobe is much larger, being from one-third to more than one-half the bulk of the right hand division.

A small elongate gall bladder similar to that found in other Caprimulgi (including *Chordeiles*[1]) underlaid the right lobe of the liver in a notch near the external margin. The pancreas was small, consisting of a single lobe that was rounded and full at the lower end, elongate and attenuate above. It was not possible to trace the hepatic and pancreatic ducts in this specimen to the point where they entered the intestine.

The spleen was placed against the anterior end of the gizzard on the right side, beneath the upper end of the right liver lobe. It was elongate with bluntly rounded ends, flattened somewhat from side to side, but in general form was cylindrical. The spleen measured 10 mm. long and the flattened face was 2.5 mm. broad.

There was only one carotid artery, a character in which *Nyctibius* resembles *Podargus* and differs from the Caprimulgidae. The left carotid passes up out of the body cavity, and then swings over to run on up the neck through the hypapophysial canal, as in a specimen of *Podargus strigoides* (Cat. No. 19361, U.S.N.M.) examined. In *Nyctibius* there is a small artery on the right side that extends to the right thyroid gland. A branch of this artery then proceeds inwards as a vertebral artery but extends no farther up the neck.

In the specimen of *Nyctibius* at hand the trachea was injured so that a detailed study of it was not practicable. It was ascertained, however that the syrinx was tracheo-bronchial, in which character this genus resembles the Caprimulgidæ.

The sternum has been studied so no details of the trunk skeleton need be given save to note that the procoracoidal process is small, not reaching the clavicle, and that there are 14 cervical vertebrae of which three bear free ribs.

There is some confusion in published accounts as to the number of cervical vertebrae in this group. Beddard[2] states that *Chordeiles* possesses 13. Gadow[3] gives 14 for *Podargus* and *Batrachostomus* and 13 for *Caprimulgus*. Fürbringer[4] says that *Caprimulgus* has 13

[1] Wetmore, Proc. Biol. Soc. Washington, vol. 28, 1915, pp. 175–176.

[2] Structure and Classification of Birds, 1898, p. 241. See also Oberholser, A monograph of the Genus Chordeiles, U. S. Nat. Mus. Bull. 80, 1914, p. 9.

[3] Bronn's Klassen and Ordnungen des Thier-Reichs, Vögel, vol. 1, 1891, p. 950.

[4] Untersuchungen zur Morphologie and Systematik der Vögel, vol. 1, 1888, table 23. pp. 780–781.

and *Batrachostomus* 14. In the following table is given the number of cervical and cervico-dorsal vertebrae (those possessing free ribs) and the number of complete ribs reaching the sternum in the species at hand at the present time:

| List of species. | Cervical vertebrae. | Free ribs. | Complete ribs. |
|---|---|---|---|
| *Steatornis caripensis* U.S.N.M. No. 18309 | 15 | 3 | 4 |
| *Podargus strigoides* U.S.N.M. No. 18572 | 13 | 2 | 5 |
| *Podargus strigoides* U.S.N.M. No. 19361 | 13 | 2 | 5 |
| *Nyctibius griseus* U.S.N.M No. 225851 | 14 | 3 | 4 |
| *Chordeiles acutipennis* A.W. No. 1265 | 14 | 3 | 4 |
| *Chordeiles virginianus* A.W. No. 1269 | 14 | 3 | 4 |
| *Chordeiles virginianus* U.S.N.M. No. 224509 | 14 | 3 | 4 |
| *Phalaenoptilus nitidus* U.S.N.M. No. 19146 | 14 | 3 | 4 |
| *Nyctidromus albicollis* U.S.N.M. No. —— | 14 | 3 | 4 |
| *Caprimulgus europaeus* U.S.N.M. No. 19359 | 14 | 3 | 4 |
| *Setochalcis vocifera* U.S.N.M. No. 17478 | 14 | 3 | 4 |
| *Antrostomus carolinensis* A.W. No. 914 | 14 | 3 | 4 |
| *Thermochalcis cayennensis* A.W. No. 1280 | 14 | 2 | 5 |

It will be noted that *Podargus* has only 13 cervical vertebrae, instead of 14, as given by other authors, and that (with the exception of *Steatornis*) all of the other genera available (including *Chordeiles* and *Caprimulgus*) possess 14.

There is enough of the base of the skull present in the specimen of *Nyctibius* examined to show that well-developed basipterygoid processes are present, a fact not previously known, as Huxley[1] figured only the palatal portion of the skull in this bird, possibly from a specimen taken from a study skin.

In addition to this the writer is unable to find a trace of an oil gland in this alcoholic specimen or in a series of skins of *Nyctibius* that are available in the collections of the United States National Museum.

The tongue (fig. 3) of *Nyctibius* is small in proportion to the size of the mouth cavity as in other Caprimulgi. In form it differs considerably from the tongues of related genera. The tip of the tongue in *Nyctibius* is somewhat elongate, with the lateral outlines at first concave. The postero-lateral margins are produced as elongate points that equal the anterior portion in length. The outline of the lateral margin of these is convex. In general the form of the tongue is that of the head of a spear point, with a deeply incised base, spreading posterior angles, and slender point. The margins of the tongue at the tip are smooth. A short distance behind small spine-like papillae appear, with the points directed backward. These increase greatly in size toward the posterior end of the tongue and extend around on the inner margins of the posterior elongations. These points are not wholly symmetrical in their arrangement upon the opposite sides of the tongue. They are firm in texture and are

[1] Proc. Zool. Soc. London, 1867, p. 454, fig. 6.

sharply pointed, but bend readily. The upper surface of the tongue appears smooth to the unaided eye, but when examined with a hand lens it is found to have a few minute spines scattered over its surface. The tongue measured 20 mm. long and the posterior prongs were 12 mm. apart.

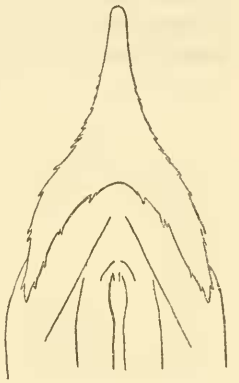

FIG. 3.—TONGUE OF NYCTIBIUS GRISEUS ABBOTTI (×2. CAT. NO. 225851, U.S.N.M.).

Examination of other species available belonging to the suborder Nycticoraciae shows four main types of tongue structure in this group. The material available includes the following: *Steatornis caripensis*, *Podargus strigoides*, *Nyctibius griseus*, *Chordeiles acutipennis*, *Chordeiles virginianus*, *Phalaenoptilus nitidus*, *Nyctidromus albicollis*, *Caprimulgus europaeus*, and *Setochalcis vocifera*. The form of tongue peculiar to *Nyctibius griseus* has been described above. Of the remaining forms *Podargus* (fig. 4) possesses a tongue most remarkable in form. This organ has been briefly described by Beddard[1] as "a curious tough but transparent membranous organ," but no other reference to its peculiarities has been found in literature available. The tongue in *Podargus* is elongate and much larger in proportion to the size of the mouth cavity than in other forms examined. The anterior end of the hyoidean apparatus forms a thickened, pointed projection in the tongue base, as shown by the line *x* in the text figure. Anterior to this strong base the tongue is thin and translucent, being not much thicker than a sheet of ordinary writing paper. The lateral outlines of this portion are slightly convex, and are somewhat irregular, due to wear of the thin, delicate margins. The tip forms an obtuse point. At the base the tongue is dilated on either side, and terminates in two pointed projections. The margins of these projections are armed with spinose papillae projecting backward, which continue around on the inner side. These papillose points are not symmetrically developed on the opposing side. The base of the tongue lies only a short distance in front of the glottis. It seems questionable whether the thin anterior portion of the tongue can serve any purpose in feeding, although that is a point to be settled only by observation of living specimens. The

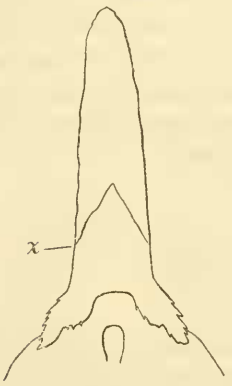


FIG. 4.—TONGUE OF PODARGUS STRIGOIDES (ABOUT NATURAL SIZE. CAT. NO. 19361, U.S.N.M.). *x*, LINE MARKING BOUNDARY BETWEEN STRONG BASE AND THIN, PAPER-LIKE TIP.

[1] Structure and Classification of Birds, 1898, p. 234.

tongue in *Podargus strigoides* is certainly one of the most curious found in the Class of Birds.

The tongue of *Steatornis caripensis* (fig. 5) has been briefly described by Garrod.[1] In two alcoholic specimens in the United States National Museum collections the tongue is shaped like an arrowhead with a rather elongate bluntly pointed tip, convex lateral outlines, and spreading, somewhat slender posterior processes that project beyond the hinder border. The margins of these posterior processes are armed with soft, slender, backward projecting papillae, and smaller papillae of the same nature are found on the upper surfaces of these projections. The arrangement of these papillose points is not symmetrical and the tongue is somewhat thickened basally, becoming thin at the anterior end. In the specimen figured (a male, Cat. No. 18309, U.S.N.M.) the tongue measured 19.5 mm. along the sides by 12 mm. broad across the spreading base. These measurements are slightly in excess of those given by Garrod.

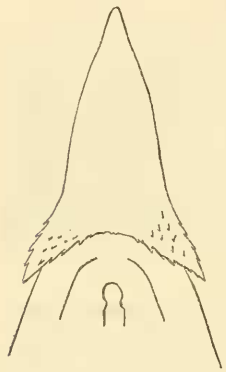

FIG. 5.—TONGUE OF STEATORNIS CARIPENSIS (×2. CAT. NO. 18309, U.S.N.M.).

The remaining genera examined all belong in the family Caprimulgidae, and in all the tongue is small, more or less triangular in form, with the posterior lateral margins and upper surface armed with papillae of varying sizes. Various modifications of this general type mark the different genera, as may be noted in the following pages. Though the tongue is small in all these forms, it must be considered that it plays a definite part in manipulating food in swallowing; otherwise the development of the basal papillae would be less marked.

In a treatise on the anatomy of *Phalaenoptilus* that species as "slender and pointed. Posteriorly it is *nitidus* Miss M. E. Marshall,[2] describes the tongue of bifid and fimbriated." In a specimen at hand this organ (fig. 6) is small, measuring 9.5 mm. long by 3 mm. broad. The postero-lateral spinose processes are elongate and pointed. The lateral margins in outline are approximately straight lines. Spinose, backward projecting papillae begin at a point anterior to the center and become stronger and heavier toward the base of the tongue. The upper surface of the tongue for its basal two-thirds is thickly set with small horny papillosities, all projecting backward. Because of

FIG. 6.—TONGUE OF PHALAENOPTILUS NITIDUS (×2. CAT. NO. 19146, U.S.N.M.).

[1] Proc. Zool. Soc. London. 1873, p. 531.

[2] A Study of the Anatomy of Phalaenoptilus Ridgway, Proc. Amer. Philos. Soc., vol. 44, 1905, p. 215. (See pl. 4, fig. 10.)

the posterior elongation of the lateral processes, the basal margin appears deeply incised, in this respect exceeding any of the other genera examined save *Nyctidromus*. The arrangement of the lateral papillary processes is not bilaterally symmetrical.

In a specimen of *Nyctidromus albicollis* the tongue is very similar to that just described and figured in *Phalaenoptilus*. Strong backward directed papillae are found on the lateral margins posterior to the middle and the arrangement of the papillae on the upper surface is somewhat different than in *Phalaenoptilus*. A row of strong spicules, four or five in number is developed on either side, and at the base the number of papillae is reduced to two or three. A slender papillus arising on the inside, at the tongue base, is about two-thirds as long as the postero-lateral process. The margins of the latter are smooth, and the processes are elongate as in *Phalaenoptilus*. The tongue measures 10.5 mm. long by 2.5 mm. broad at the base.

The tongue of *Caprimulgus europaeus* has been described briefly by William MacGillivray[1] who notes (p. 634) that it "is extremely small, slender, slightly papillate at base, having also some papillae on its upper surface, tapering to an obtuse point." In a specimen at hand (Cat. No. 19359, U.S.N.M.) the tongue resembles that of *Phalaenoptilus nitidus*, but has the postero-lateral spines much less elongate. The tongue in this specimen measures 10 mm. long by 3 mm. broad at the base. In outline the lateral margins are nearly straight, so that in profile the tongue is like an elongate triangle. Pointed papillae projecting backward begin on the margins at a point anterior to the middle and continue to the base. The last in the series toward the base of the tongue are the largest. The postero-lateral spines are moderately elongate and there are no other projections from the posterior margin. Small scattered conical papillae cover the posterior half of the upper surface. Toward the base there is one row on either side of the center composed, respectively, of two and three papillae each that point in toward the center.

The tongue of *Setochalcis vocifera* has likewise been described by MacGillivray[2] who notes that it is "slender, tapering to a point, very thin, with two long-pointed papillae at the base, and numerous small papillae on its upper surface." In specimens examined by the writer the tongue in this species also resembles that described in *Phalaenoptilus nitidus*. In form it is slender and elongate with a triangular outline. One specimen seen (Cat. No. 223661, U.S.N.M.) is 10.5 mm. long by 3 mm. broad at the base. Spinose processes appear on the margin about one-half of the distance back from the tip; these increase slightly in size toward the posterior part of the

[1] History of British Birds, London, vol. 3, 1840, pp. 630 and 634.
[2] In Audubon, J. J., Ornitholigical Biography, Edinburgh, 1839, vol. 5, p. 306.

tongue. The postero-lateral spines are elongated as slender, pointed processes, and there are six or seven small backward-projecting papillae on the upper surface of the tongue near the base. The hyoidean muscles in this species are very slight in development.

No alcoholic specimen of *Antrostomus carolinensis* is at hand, but the tongue in this species (also described by William MacGillivray[1]) is said to be "very small, * * * attenuated, tapering, flat above, covered with papillae, of which there is a large one at the base on each side; the tip is narrow, but rather obtuse." No drawing showing the tongue is given, but from the description quoted it is evident that it resembles in general type the tongues of *Phalaenoptilus*, *Caprimulgus*, and *Setochalcis*.

The tongue of *Chordeiles virginianus*, while similar to that of other Caprimulgidae, shows a slightly different development. This organ in the nighthawk (fig. 7) is small in comparison to the size of the mouth opening, but is strong and heavy. It measures approximately 9 mm. long by 4.7 mm. broad at the base, so that it is short and broad in comparison with the lingual appendages of other genera in this family that have been described. This difference was noted by MacGillivray[2] in his dissections of birds made for Audubon. In outline the tongue of *Chordeiles virginianus* is triangular, with the lateral margins slightly concave. The postero-lateral angles are produced as curved spinose processes, and the line of the base is incised at the center. The lateral margins of the tongue are armed with spinose papillae, which are small and weak anteriorly and become strong and heavy toward the base. Stronger processes arm the posterior margin, and the broadened basal third of the tongue has its dorsal surface covered with pointed, harsh papillosites, all directed toward the pharynx. The hyoidian muscles are fairly strong and well developed.

FIG. 7.—TONGUE OF CHORDEILES VIRGINIANUS (×2. CAT. NO. 225265, U.S. N.M.).

In *Chordeiles acutipennis* the tongue resembles that described in *C. virginianus* but is smaller, measuring only 7.5 mm. long by 4.5 mm. broad at the base. The postero-lateral spines are somewhat longer so that the posterior margin appears more deeply incised. The lateral outlines and the arrangement and size of the spines are practically the same as in the larger nighthawk. The tongue is these birds, though small, appears so much stronger than in the other Caprimulgidae and is so heavily armed with papillae that it must be supposed that it plays an important rôle in the swallowing of food. Certainly the development of spines is so striking that the tongue in this genus can not be considered rudimentary or functionless.

[1] Audubon, J. J., Ornithological Biography, Edinburgh, 1839, vol. 5, pp. 402–403.
[2] Idem, p. 407.

The relationships of the goatsuckerlike birds of the groups characterized by the genera *Podargus*, *Nyctibius*, and *Caprimulgus* have been interpreted in various ways by different authors. Sharpe[1] placed *Podargus* in a suborder Podargi of the Coraciiformes, while he united *Nyctibius*, which he considered as the type of a distinct family, the Nyctibiidae, with the Caprimulgidae in another suborder, the Caprimulgi. Beddard[2] and Gadow[3] on anatomical grounds joined all these with *Steatornis* under one suborder known as the Caprimulgi.

Mr. Ridgway[4] in his recent treatment of the group has proposed a suborder Nycticoraciae to include the superfamilies Caprimulgi (Caprimulgidae + Nyctibiidae), Podargi (Podargidae) and Steatornithes (Steatornithidae).

The grouping of *Steatornis*, *Podargus* and its allies, *Nyctibius*, and the various genera belonging to the Caprimulgidae in one suborder under the Coraciiformes is one that seems logical in view of the facts known through modern research into the affinities of these birds. *Steatornis* as an outlying aberrant form, though seeming to belong to this suborder, is so different from the other genera included in the Nycticoraciae that it is readily separated from them in a well circumscribed division, and may be dismissed without further comment. A survey of the facts now known concerning the anatomy of *Nyctibius*, however, together with the structural characters of this genus previously recorded, serve to show that the gap between the two remaining superfamilies recognized by Mr. Ridgway is less trenchant and sharply defined than has been supposed. In the following table are given the details of 12 of the main structural characters of use in the classification of the members of this group remaining after *Steatornis* is removed.

| | *Podargus.* | *Nyctibius.* | Caprimulgidae. |
|---|---|---|---|
| Oil gland | Absent. | Absent. | Present. |
| Powder down patches | Present. | Present. | Absent. |
| Carotid arteries | One (left). | One (left). | Two. |
| Syrinx | Bronchial. | Tracheo-bronchial. | Tracheo-bronchial. |
| Left liver lobe | More than one-half as large as right. | One-fifth as large as right. | One-third to one-half as large as right. |
| Tongue | Large, with transparent paperlike tip, spinose basally. | Medium, shaped like a spearhead, feebly papillate. | Small, triangular in outline, more or less spinose. |
| Cervical vertebrae | 13. | 14. | 14. |
| Sternum | Four notched. | Four notched. | Two notched. |
| Procoracoidal process | Large, reaching furculum and scapula. | Small, not reaching furculum. | Small, not reaching furculum. |
| Basipterygoid processes | Absent. | Present. | Present. |
| Palatines | Broad throughout, slightly expanded posteriorly. | Narrow anteriorly, greatly expanded posteriorly. | Narrow anteriorly, greatly expanded posteriorly. |
| Number of phalanges in fourth toe. | Five. | Five. | Four. |

[1] Review of Recent Attempts to Classify Birds, 1891, pp. 79, 81.

[2] Structure and Classification of Birds, 1898, pp. 231–244.

[3] Classification of Vertebrata, 1898, pp. 36–37.

[4] Birds of North and Middle America, Bull. 50, U. S. Nat. Mus., part 6, 1914, pp. 487–489.

It will be noted that in five of the characters outlined, *Nyctibius* agrees with the Podargidae, and in five with the Caprimulgidae. In the absence of an oilgland, presence of powder down patches, single carotid artery, four notched sternum, and the possession of five phalanges in the fourth toe *Nyctibius* resembles *Podargus* (here taken as typical of the family Podargidae). While in its tracheobronchial syrinx, 14 cervical vertebrae, presence of basipterygoid processes, development of the procoracoidal process, and the form of its palatines *Nyctibius* is similar to the Caprimulgidae. It is seen from a study of these points then, that, as Gadow stated,[1] the Nyctibiidae seem to form an intermediate group between the other two. Study and comparison of the known characters of *Aegotheles* which forms another family of this group, the Aegothelidae, serves to narrow the gap between Podargidae and Caprimulgidae still more.[2] It is thought that the two major groups will be found still more closely allied when more is known of *Aegotheles*, and when *Batrachostomus* has been more carefully investigated. From present knowledge *Batrachostomus* seems to belong in the family Podargidae as it is said to have a four-notched sternum, a bronchial syrinx, and a desmognathous palate, while it lacks basipterygoid processes. It differs from *Podargus* in possessing an oil gland.

From the facts outlined above it seems that the suborder Nycticoraciae of the Order Coraciiformes may be divided into two superfamilies, the Steatornithoidae with the single genus *Steatornis* and the Caprimulgoidae with the families Podargidae, Nyctibiidae, Aegothelidae, and Caprimulgidae. In the second superfamily the Podargidae, though specialized, are considered lowest and the Caprimulgidae highest in development. The Nyctibiidae and the Aegothelidae seem to be about on the same level, though on the whole the latter seems the more primitive.

[1] Bronn's Klassen und Ordnungen des Thier-Reichs, Vögel, vol. 2, p. 243.

[2] As alcoholic specimens or skeletons of *Aegotheles* are not available, the writer is indebted for information on this genus and on *Batrachostomus* to the following: Beddard, Structure and Classification of Birds, 1898, pp. 231–244; Gadow, Bronn's Klassen und Ordnungen des Thier-Reichs, Vögel, vol. 2, pp. 242–243; to brief notes gleaned from other sources, and to such characters as are available from the study of skins.